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Nuclear Forensic Field Exercise #1

Work performed in support of CRTI Project 04-0030TD

Carey Larsson and Anthony Hinton

Defence R&D Canada – Ottawa

TECHNICAL MEMORANDUM
DRDC Ottawa TM 2006-214
November 2006

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Abstract

DRDC Ottawa is leading a project designed in part to develop protocols for forensic investigators working in a radiologically contaminated environment. As such, a radiological field exercise was held to review current forensic investigator methods and identify problem areas with respect to the collection of evidence from a contaminated crime scene. The Canadian Nuclear Safety Commission (CNSC), DRDC Ottawa, Royal Canadian Mounted Police (RCMP) and the Ottawa Police Service (OPS) CBRN Forensic Investigation Specialists participated in the exercise. This document provides a description of the scenario and the responder actions during the exercise, and gives lessons learned and recommendations that will feed directly into the forensic investigator protocols.

Résumé

RDDC Ottawa dirige un projet conçu en partie pour élaborer des protocoles à l’intention des enquêteurs judiciaires qui travaillent dans un environnement contaminé par une substance radioactive. Ainsi, un exercice radiologique pratique a été organisé dans le but d’examiner les méthodes actuelles qu’utilisent les enquêteurs judiciaires et de cerner les secteurs problématiques liés à la collecte de preuves sur un lieu de crime contaminé par une substance radioactive. La Commission canadienne de sûreté nucléaire (CCSN), RDDC Ottawa, la Gendarmerie royale du Canada (GRC) et les spécialistes des enquêtes judiciaires CBRN du Service de police d’Ottawa (SPO) ont participé à l’exercice. Le présent document renferme une description du scénario et des mesures prises par les intervenants pendant l’exercice, de même qu’il présente les leçons tirées de l’exercice et les recommandations appliquées directement aux protocoles des enquêteurs judiciaires.

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Executive summary

Nuclear Forensic Field Exercise #1

Larsson, C.L., Hinton, A.; DRDC Ottawa TM 2006-214; Defence R&D Canada – Ottawa; November 2006.

Introduction or background

A nuclear forensic field exercise was held in support of the CRTI project 04-0030TD. The objectives of the exercise included testing forensic identification specialist (FIS) techniques for on-site recovery and analysis (both on scene and off) of traditional evidence in an R/N-contaminated environment, as well as sample collection and evidence packaging for later delivery to an R/N lab.

Results

This field exercise was successful in testing FIS techniques for on-site evidence recovery at a radiologically contaminated crime scene; however several discussion points and lessons learned were identified. While responders were successful in processing the contaminated crime scene, the most significant issue raised during this exercise was the disposition of radiologically contaminated forensic evidence post collection, since traditional forensic laboratories cannot accept radiological materials. Having the on-site capability to perform radiological analysis was determined to be an asset.

Significance

Identification of a facility (or facilities) capable of accepting radiologically contaminated materials and investigation of traditional forensic analysis techniques on those materials is required. Furthermore, an on-site capability to perform low-level radiation detection, isotope identification, and, to some extent, quantification combined with advice from on-site scientific experts, allows for improved safety to response personnel.

Future plans

The next important phase of such an exercise is to test the transportation of radiologically-contaminated evidence and radiological samples to a nuclear forensic laboratory for further analysis. Collaboration between the radiological scientific community and the forensic science community is required in order to develop solutions to deal with such contaminated evidence. Until a solution is found, our ability to achieve attribution following an R/N incident will remain uncertain.

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Sommaire

Nuclear Forensic Field Exercise #1

Larsson, C.L., Hinton, A.; DRDC Ottawa TM 2006-214; R & D pour la défense Canada – Ottawa; novembre 2006.

Introduction ou contexte

Un exercice radiologique pratique a été organisé à l'appui du projet 04-0030TD de l'IRTC. Les objectifs de l'exercice incluent l'essai des techniques des spécialistes en identification judiciaire (SIJ) de prélèvement et d'analyse sur place (sur la scène et en dehors) des preuves habituelles dans un environnement contaminé par une substance radiologique/nucléaire, de même que la collecte d'échantillons et l'emballage de preuves à livrer plus tard à un laboratoire radiologique/nucléaire.

Résultats

L'exercice pratique a permis de faire l'essai, avec succès, de techniques SIJ de récupération de preuves sur place, sur un lieu de crime contaminé par une substance radiologique. Par ailleurs, on a identifié plusieurs sujets de discussion et tiré certaines leçons. Bien que les participants aient réussi à fouiller le lieu de crime contaminé par une substance radioactive, le point le plus important soulevé pendant l'exercice a été la disposition, après sa découverte, de la preuve légale contaminée, parce que les laboratoires judiciaires traditionnels ne peuvent accepter les matériaux radiologiques. Le fait d'avoir sur place la capacité d'effectuer des analyses radiologiques est jugé comme un atout.

Importance

Il est essentiel de trouver une installation (ou des installations) capable d'accepter des matériaux contaminés par une substance radioactive et d'utiliser des techniques d'analyse judiciaire traditionnelles à l'égard de ces matériaux. En outre, une capacité sur place de détection des rayonnements de faible niveau, d'identification et, dans une certaine mesure, de quantification d'isotopes, associée à des conseils de spécialistes scientifiques sur place, permet d'améliorer la sécurité du personnel d'intervention.

Perspectives

La prochaine étape importante de ce genre d'exercice consiste à vérifier le transport d'une preuve contaminée par une substance radioactive et d'échantillons radiologiques à un laboratoire judiciaire nucléaire pour des analyses plus poussées. La collaboration entre la collectivité scientifique de radiologie et la collectivité de la science judiciaire est essentielle à l'élaboration de solutions permettant la manipulation de ce genre de preuve contaminée. Jusqu'à ce que nous

trouvions une solution, notre capacité à faire les affectations à la suite d’un incident radiologique/nucléaire demeurera incertaine.

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Acknowledgements

We would like to thank Bob Kurus, Dwayne Raymond, Frank Cloake, and Shawn Rainville from the Ottawa Police Service Criminal Investigations Forensic Identification Section for their participation in the nuclear forensic field exercise, which was held in an unheated building in the middle of January. The lessons that were learned from their participation in these exercises will help in the development of Canadian forensic investigator protocols for working in a radiologically contaminated environment. We would also thank Sergeant Mike Tessier for providing the training facilities and many of the props used in the exercise, and for his participation in the exercise.

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1. Introduction

The consequences of radiological terrorism, currently a serious threat, would likely involve widespread radiological contamination. In such a situation, information related to who perpetrated the attack, how it was performed, what material was used, and from where the material originated will unquestionably be of great importance to investigators and government officials. Much of this information will be garnered from both traditional and nuclear forensic investigations and analysis. The existence of adequate protocols for field investigators and qualified laboratory networks to acquire and analyse data are thus extremely important to ensure eventual attribution.

To address these issues, the Chemical, Biological, Radiological, Nuclear (CBRN) Research and Technology Initiative (CRTI) has funded a project entitled “Nuclear Forensic Response Capabilities and Interoperability” (CRTI-04-0030TD). The main objectives of this project are:

- to establish protocols which will allow forensic identification specialists to achieve attribution despite a radiological/nuclear (R/N) contaminated site
- to develop and test the nuclear forensic laboratory analysis methods to further our attribution capabilities; and
- to create links between scientific responders and forensic identification specialists, paving the way for knowledge sharing in the field.

One step in achieving these objectives includes the design and prosecution of a series of field and laboratory exercises aimed at testing capabilities and revealing gaps in R/N response. This will, in turn, identify further work needed in the context of the project. As such, this document describes the first field exercise.

The exercise was one-day in length, and consisted of a crime scene involving both sealed and unsealed radioactive material (^{137}Cs and ^{99m}Tc, respectively) as well as a variety of potentially contaminated forensic evidence. The objectives of the exercise included testing forensic identification specialist (FIS) techniques for on-site recovery and analysis (both on scene and off) of traditional evidence in an R/N-contaminated environment, as well as sample collection and evidence packaging for later delivery to an R/N lab. The scenario for this exercise was specifically designed to meet these objectives.

This radiological forensic investigator field exercise was held in collaboration with the Royal Canadian Mounted Police (RCMP), the Canadian Nuclear Safety Commission (CNSC), DRDC Ottawa, and Ottawa Police Services (OPS). Section two presents the exercise description; section three describes the conduct of the exercise and lessons learned; section four provides some recommendations for forensic specialists; section five outlines the conclusions of the participants.

2. Exercise Description

The forensic investigator field exercise was developed and deployed by CNSC and DRDC Ottawa. This section of the document begins with the scenario description, and then describes the actions taken during the field exercise.

2.1 Scenario

Two suspects attempted to rob an ESSO gas station 450 BANK ST (at GLADSTONE AVE). Suspect # 1 was armed with a large knife and demanded cash from the gas bar clerk, while suspect # 2, not visibly armed, remained at the door as lookout. A plain-clothes Ottawa Police Services (OPS) sergeant at the TIM HORTON'S counter identified himself and challenged both suspects. Suspects # 1 and # 2 submitted to the officer and were taken into custody at the scene without incident. Both suspects were searched: suspect # 2 was in possession of a Beretta model 92FS 9 mm handgun. Neither suspect had any identification on them.

A white late model Cadillac sedan was then seen fleeing the scene southbound on BANK ST at high speed. There appeared to be only one occupant, Suspect # 3, a white male in his late 20s. Suspects #1 and #2, both white males in their mid-20s, were questioned at OPS Central Station, but refused to provide any information to officers regarding identity, motive, etc. A review of the ESSO security tape yielded several images of the sedan seen fleeing the scene of the attempted armed robbery. A licence plate was identified, leading investigators to believe the car was being driven by its registered owner, Suspect # 3, of SOUTHPARK DR in the Blackburn Hamlet area of the city.

OPS Tactical Unit officers entered the residence at 32 SOUTHPARK DR to serve a warrant to Suspect # 3, however found no one home. Officers found a workshop / laboratory in the home with bomb-making literature, radioactive labels (trefoils), lead containers, and various tools. Some electronic dosimeters, carried by OPS, alarmed, indicating high gamma ray dose rates. The street was cordoned off and the home was turned over to OPS Explosives Disposal Unit (EDU) and Forensics Identification Section officers. EDU officers confirmed that no explosives hazard was present in the home and cleared the scene for processing by FIS officers.

2.2 Field Exercise Actions

The field exercise for scenario one was held on January 17th, 2006 at the RCMP Technical and Protective Operational Facility in Ottawa, Ontario. A schematic of the trailer used for the exercise is shown in Figure 1. Four officers from the OPS Criminal Investigations Forensic Investigation Section responded in the exercise, along with one RCMP FIS officer. The scenario was conducted as training rather than an exercise, with the RCMP officer providing guidance over the radio. Radiological advice was given by a CNSC expert and a DRDC Ottawa defence scientist. The CRTI/DRDC Ottawa Mobile Nuclear Laboratory (MNL) was onsite, and a DRDC Ottawa technologist performed analyses of samples taken from the crime scene.

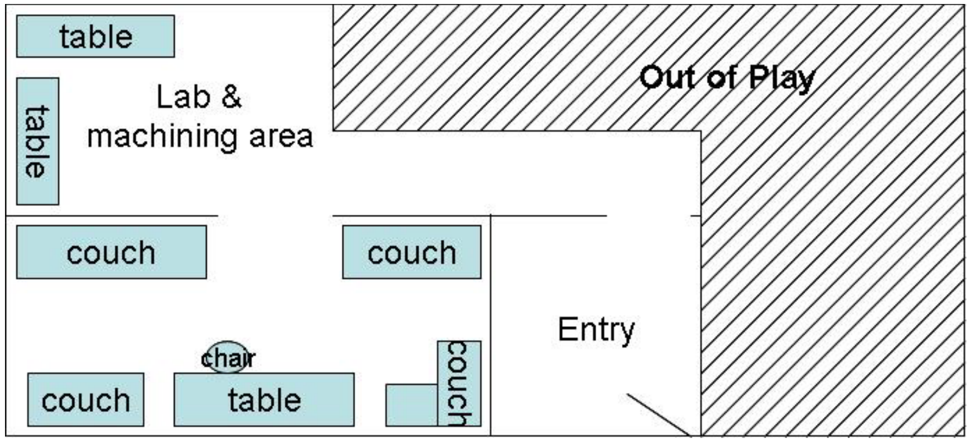

Figure 1: Schematic of the trailer used in the exercise

The trailer was set up to mimic a hide out for an organized crime group engaged in stealing, converting to dispersible form and selling radioactive material on the black market. In the laboratory and machining area, two tables were set up, one holding some basic laboratory equipment and the other holding both a grinder surrounded by lead and some potential bomb-making paraphernalia (i.e. a cell phone, battery, wires, etc). In the other room, several couches abutted on the walls and a table was placed along the centre of the long wall. On the table were a handgun, several documents on construction of dirty bombs, a fake CNSC license for the possession of a variety of radioactive materials, and a pile of counterfeit currency. A second handgun was wedged between the cushions of one of the couches (see Figure 2). Several small sealed ^{137}Cs sources were placed in both rooms and unsealed ^{99m}Tc in liquid form was poured onto the lab table, the grinding area, the floor in front of these tables, as well as on the guns, documents, money, and floor of the other room.

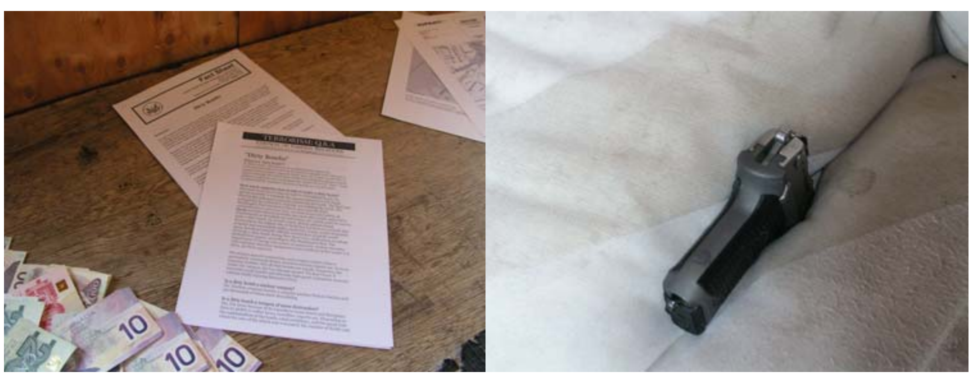

Figure 2: Set up of the crime scene showing the table with documents and money on the left and the handgun wedged in a couch on the right.

The timeline for the field exercise is outlined below:

1. The RCMP forensic identification trailer and the Mobile Nuclear Laboratory (MNL) were pulled into the area and parked approximately 30 m from the scene.

2. The responders established the proper personal protective equipment (PPE) for entering this site based on the information given in the scenario. (This included C4 mask, double gloves, overboots, Tyvek or equivalent suit)

3. Five FIS, two RAD experts and two exercise coordinators suited up and donned EPDs.

4. Equipment was checked and placed on a small wagon and a clean dirty line was established approximately 25 m from the trailer.

5. A team of four FIS and one exercise coordinator approached the trailer with the wagon and radiation detection equipment in hand (a TBM-3S pancake $\alpha\beta$ probe and an Automess 6150AD γ probe) while the other responders remained at the clean/dirty line.

6. Dose-rate measurements were taken on the stairs and throughout the entry area of the trailer and FIS equipment was brought into the entry area and laid on a sheet of Mylar placed on the ground.

7. The FIS team, consisting of a videographer, a scribe, and two officers carrying radiation detection equipment, along with the exercise coordinator, entered the remainder of the residence to perform an initial radiological reconnaissance. This was comprised of quick dose-rate measurements of the house, and localization of large radioactive sources, which were then marked with a piece of paper displaying an evidence identifier and the dose-rate and distance reading on it. The area was also photographed.

8. The survey of the house was completed and radiation experts were radioed in to remediate the identified sealed sources. This was accomplished with the use of radiation lead “pigs” provided by the exercise coordinator. Once the sealed sources were secured, the dose-rate in the house was reduced to a reasonable working level.

9. The FIS teams then proceeded to gather evidence including fingerprints, DNA, documents, photography/videography, and some material samples (shown in Figure 3). The team worked with a “clean” and a “dirty” man approach for evidence collection in order to prevent cross-contamination of the samples. The photographer and scribe documented the proceedings.

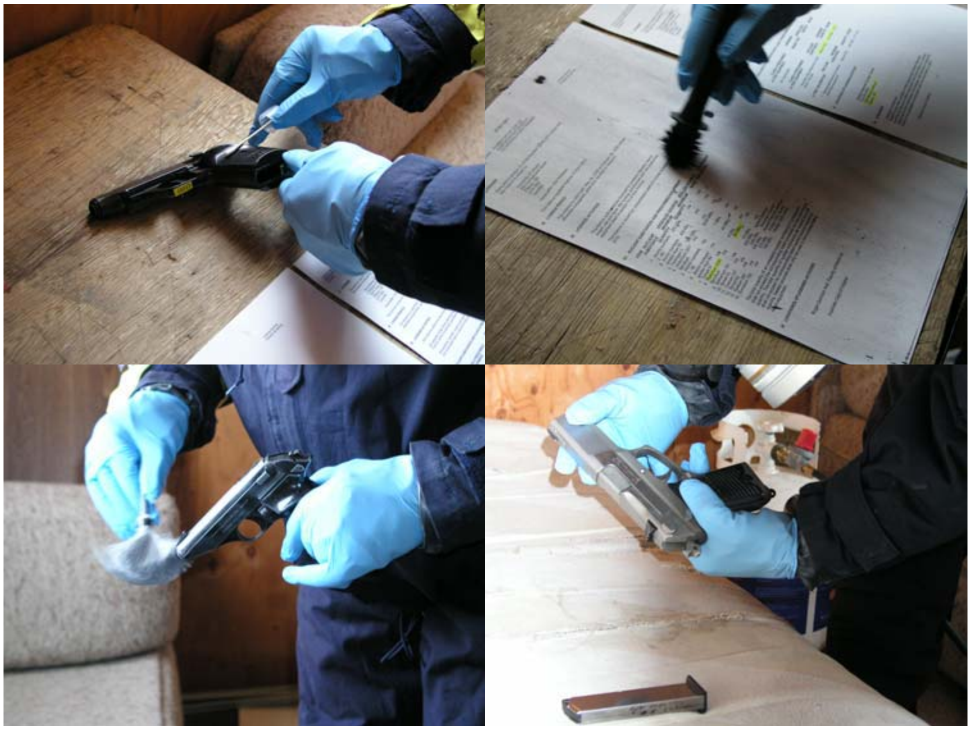

Figure 3: Forensic collection and analysis performed in the crime scene

Fingerprinting of evidence was performed by dusting with powder. Documents at the scene were the first items to be examined for fingerprints. Documents with prints were double bagged and checked for contamination. Documents without prints were photographed for further analysis at a forensic laboratory.

The handguns were examined next, however DNA swabbing was performed prior to dusting for fingerprints. A swab of the grip of both handguns was taken for DNA analysis and placed in double evidence bags. However, when checked for contamination with the $\alpha\beta$ probe, the swab was found to be contaminated and was instead sent through the clean/dirty line and given to MNL personnel for on-site analysis. Analysis of the contaminated swab was performed with the MNL's high purity Germanium detector (Ortec, Oak Ridge, TN) and ^{99m}Tc was identified. The handguns were then rendered safe (i.e. unable to function) and photographed by the videographer.

The counterfeit currency was photographed by the videographer and then checked with the gamma survey meter for contamination (in bulk). Elevated radiation readings were observed in the vicinity of the currency, and so the currency was left on the table.

Miscellaneous materials including the metal filings and liquid in a chemical jar were also checked with a gamma survey meter, showing elevated readings. These were sampled and all were found to be contaminated. Samples were all double bagged and sent through the clean/dirty line to be given to MNL personnel for on-site analysis.

Once these steps were complete, the exercise was terminated. Equipment was checked for contamination at the scene and then loaded onto the wagon to return to the contamination

checkpoint. At the checkpoint, the RCMP responder performed a thorough contamination check on all of the responders and equipment. The equipment was contamination-free, however all OPS responders were found to have the bottom of their Tyvek boot-covers contaminated. When the boot covers were removed, labelled and stored appropriately, a check of the bottom of two of the responder's boots also revealed contamination. These responders changed into spare boots, bagged the contaminated boots, and left them to allow the ^{99m}Tc to decay to acceptably low levels prior to retrieving them. The trailer was locked up for three days to allow for decay of the ^{99m}Tc to background levels.

3. Lessons Learned

Conduct of this scenario identified several discussion points with respect to the processing of a radiologically contaminated crime scene. These points were noted by the exercise coordinators both during the exercise and in the post-exercise hot-wash. This section discusses the salient points.

As is the case with most training exercises, several general yet significant items were observed. One such item was the fact that the FIS responders took some time at the beginning of the exercise to familiarize themselves with the radiation detection equipment and particularly with radiation units. This is entirely understandable and would be mediated with increased practice and training opportunities. Other items, such as the use of call names over radio, were also raised. It should be pointed out that the OPS responders do not own EPDs or radiation detection equipment (both used for this exercise were provided by CNSC). This has been pointed out in previous exercise reports [1], and it is felt that these responders should purchase EPDs at minimum.

During the later part of the exercise, dates and labels were not being written on the collected forensic evidence bags. It was pointed out during the hot-wash that the pen that was brought into the scene became contaminated in the early stages of the exercise and thus could not be used to label packages. To mitigate this problem, the scribe wrote down all details regarding each piece of collected evidence. For items as small as a pen, multiples should be available in the forensic kit.

As mentioned in the previous section, the responders that were wearing Tyvek over-boots saw these tear, causing their under-boots to get contaminated. The responders wearing the grey reinforced over-boots did not have this problem. The reinforced over-boots should therefore be used in future exercises (and in the real-world). It was pointed out that it is good practice for responders to perform a quick contamination check of each others hands and feet before exiting a contaminated enclosed area and thence removing identified contaminated articles (only on hands or feet). This would prevent potentially long-lived radioisotopes from being tracked outdoors to the contamination checkpoint. That said, it would not have been very helpful in this case since the under boots of two responders were also contaminated!

On-site fingerprint analysis can be performed on contaminated items with identified prints being photographed for analysis off site. Contaminated documents can also be photographed for off site analysis. DNA analysis of contaminated items cannot be performed at any forensic laboratory - mainly due to the fact that they do not hold a permit to accept and hold radioactive material. It is possible that this type of analysis could be performed at the DRDC Ottawa Radiation Biology lab, but this has not yet been investigated. Further to this, the effects of radiation on DNA analysis equipment would need to be assessed. Most other types of forensic evidence analysis can not be performed on contaminated evidence.

While the handguns were fingerprinted, swabbed for DNA, found to be contaminated, rendered safe and thoroughly photographed, they were not bagged as evidence and were left at the scene at the conclusion of the exercise. Similarly, the counterfeit currency was identified as contaminated and photographed, but left at the scene upon exercise completion. While a contaminated crime scene would most certainly be cordoned off and placed under some type of security, removal of

the contaminated weapons and currency would be necessary at some point. Double or triple bagging these items, tagging them and transferring them to a secure location with the proper facilities (and licenses) would be the ideal solution. At that location, attempts to decontaminate the items could be made; otherwise long term storage at a radiological facility (such as CNSC or DRDC Ottawa) would be required. The next important phase in this series of exercises is to test the transportation of radiologically-contaminated evidence and radiological samples to a nuclear forensic laboratory for further analysis.

Due to the inability of traditional forensic laboratories to accept radiologically contaminated materials, having an on site capability to perform low-level radiological detection, isotope identification, and, to some extent, quantification is a bonus. For this exercise, the presence of the MNL at the scene to perform assessments of contaminated swabs and other items that were passed through the clean/dirty line allowed for rapid determination of the extent and nature of the contamination. This, combined with advice from on site scientific experts, allowed for improved safety to response personnel.

4. Recommendations and Conclusions

These field exercises for forensic investigators were extremely useful in highlighting areas requiring further work. The largest gap identified during this exercise is that of the disposition of contaminated forensic evidence. In general, it is imperative to use photography or other on site techniques (i.e. the use of cyanoacrylate for fingerprinting) as much as possible. This recommendation is obviously limited to only certain types of evidence.

A discussion was held during the hot-wash regarding the possible locations for forensic analysis, and concomitant capabilities. It was determined that the OPS can perform fingerprint analysis at their lab, but all other types of evidence analysis would need to be performed by either the RCMP Forensic Laboratory Services (FLS) or the Centre of Forensic Sciences (CFS). However, when the evidence is contaminated the situation is quite different as these laboratories cannot accept radioactive material. It is therefore good protocol to have ‘clean’ evidence screened by radiation experts in a low background area before transporting to a forensic lab. This will ensure acceptable radiation activities.

With that said, the procedures in place at forensic laboratories are such that acceptance of a small amount of radioactive material (i.e. amounts less than an exemption quantity) would not cause any major health or safety concerns. This is due to that fact that slightly contaminated evidence would be at least sealed in a double bag, which would be opened and the samples then analysed in a fume hood. Furthermore, contamination amounting to less than an exemption quantity for a particular radioisotope does not require a permit. Quantification of the extent of contamination before sending the material to such a laboratory would thus be paramount in these circumstances. However, these issues would need to be reviewed and approved by the forensic laboratories in question. The creation of a number of evidence and material triage facilities (as is being investigated in the CRTI project 05-0123TD) would certainly address many of these issues. Under this project, an unknown or loosely quantified piece of evidence would be sent to a facility with the capability to accept CBRNE materials for screening and quantification before forwarding it on to any laboratory (forensic, radiological, or other).

As mentioned in the previous section, field exercises with more traditional responders (police, fire, and EMS) often highlight radiation detection equipment familiarization issues. While these responders have often received either Intermediate or Advanced level CBRN training from the First Responder Training Program, this training is often not backed up with further familiarization sessions in the form of classroom or field exercises on a continuous basis. As with anything that goes unpractised, details such as the meaning and definition of radiation units become confused and this can have dire impact on responder safety. One solution to this would be to hold a series of small-scale radiological field exercises several times per year across the country, inviting members of the CRTI Forensic Cluster to participate.

By and large, the biggest gap identified in this exercise was the correct handling of contaminated forensic evidence, such as handguns and counterfeit currency. In addition to this, one of the most commonly discussed forms of radiological terrorism –the radiological dispersal device (RDD) or dirty bomb – would produce contaminated explosive fragments. Trace evidence could then not be analyzable due to the issues surrounding contamination entering forensic laboratories. This issue

requires cooperation between the radiological scientific community and the forensic science community in order to develop solutions to fill this gap.

Overall, this exercise highlighted the current capabilities of the forensic investigation community to work at a radiologically contaminated crime scene. While several gaps have been identified, preparedness in this area is viewed as strong. Collaboration between forensic investigators, forensic scientists, and radiological experts will certainly help to close some of these gaps, thus furthering Canada’s preparedness to respond to a radiological incident.

References

[1] Larsson, C. L., et al. (2006), Radiological Field Exercises for Forensic Investigators, (DRDC Ottawa TM 2006-118) Defence R&D Canada - Ottawa.

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List of symbols/abbreviations/acronyms/initialisms

CBRNE	Chemical Biological Radiological Nuclear and Explosives
CFS	Centre of Forensic Sciences
CNSC	Canadian Nuclear Safety Commission
CRTI	CBRN Research and Technology Initiative
DNA	Deoxyribonucleic Acid
DND	Department of National Defence
DRDC Ottawa	Defence Research and Development Canada – Ottawa
EDU	Explosives Disposal Unit
EMS	Emergency Medical Services
EPD	Electronic Personal Dosimeter
FIS	Forensic Identification Specialists
FLS	Forensic Laboratory Services
HAZMAT	Hazardous Material
MNL	Mobile Nuclear Laboratory
OPS	Ottawa Police Service
PPE	Personal Protective Equipment
RAD	Radiation
RCMP	Royal Canadian Mounted Police
R/N	Radiological/Nuclear

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DRDC Ottawa is leading a project designed in part to develop protocols for forensic investigators working in a radiologically contaminated environment. As such, a radiological field exercise was held to review current forensic investigator methods and identify problem areas with respect to the collection of evidence from a contaminated crime scene. The Canadian Nuclear Safety Commission (CNSC), DRDC Ottawa, Royal Canadian Mounted Police (RCMP) and the Ottawa Police Service (OPS) CBRN Forensic Investigation Specialists participated in the exercise. This document provides a description of the scenario and the responder actions during the exercise, and gives lessons learned and recommendations that will feed directly into the forensic investigator protocols.

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Nuclear forensics, field exercise, radiological terrorism, forensic identification specialist

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